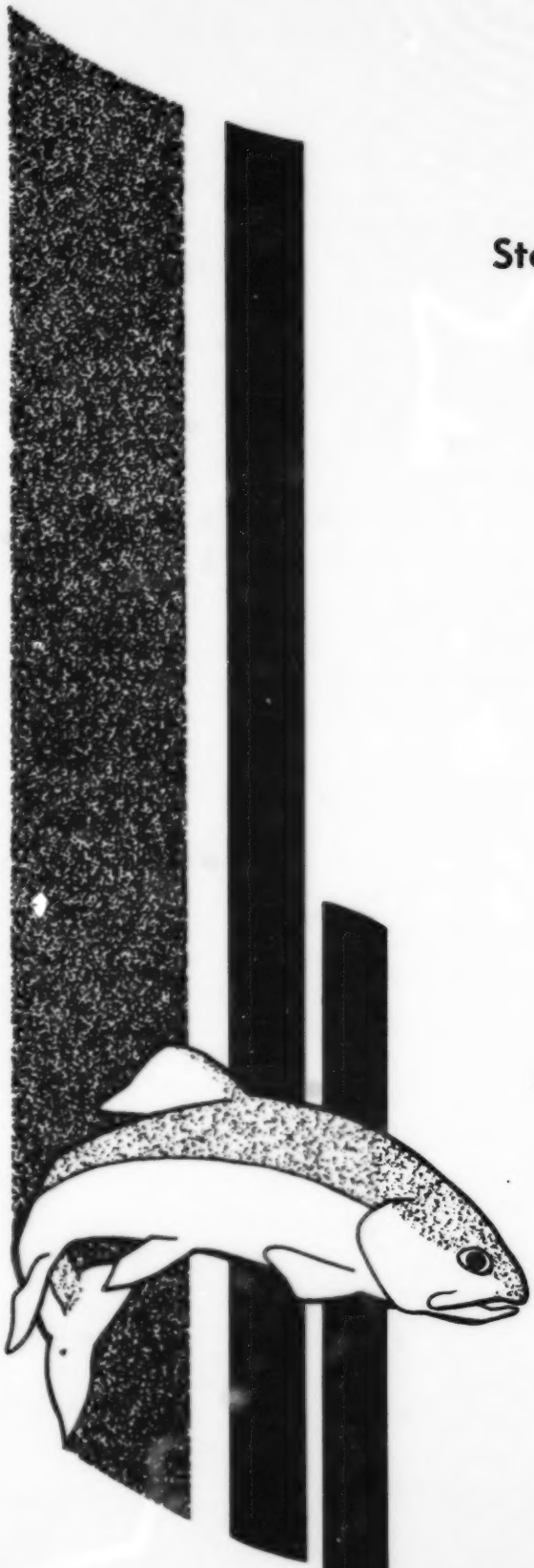


Big Qualicum River Steelhead Fishery Investigations, 1976 to 1981

by

R. S. Hooton

V. A. Lewynsky

FISHERIES MANAGEMENT REPORT No. 85

1985

Province of British Columbia

Ministry of Environment

Fisheries Management Reports are documents relevant to sportfish management in British Columbia, but for various reasons were not submitted for publication in this form are not generally reviewed by referees outside the Fisheries Branch.

BIG QUALICUM RIVER STEELHEAD FISHERY INVESTIGATIONS, 1976 TO 1981

by

R.S. Hooton[1]
V.A. Lewynsky[2]

[1]Ministry of Environment, 2569 Kenworth Road, Nanaimo, B.C., V9T 4P7
[2]Western Renewable Resources, Vernon, B.C.

Fisheries Management Report No. 85
1985

90-06972/

Canadian Cataloguing in Publication Data

Hooton, R. S.

Big Qualicum River steelhead fishery investigations, 1976 to 1981

(Fisheries management report, ISSN 0705-5390 ; no. 85)

Issued by the Fisheries Branch.
Bibliography: p.
ISBN 0-7726-0423-1

1. Steelhead fishing - British Columbia - Big Qualicum River. 2. Fishery management - British Columbia - Big Qualicum River. 3. Fish stocking - British Columbia - Big Qualicum River. 4. Fishing surveys - British Columbia - Big Qualicum River. I. Lewynsky, V. A. II. British Columbia. Ministry of Environment. III. British Columbia. Fisheries Branch. IV. Title. V. Series: Fisheries management report (British Columbia. Fisheries Branch) ; no. 85.

SH167.T86H662 1985 333.95'6 C86-092034-8

ABSTRACT

Hooton, R.S. and V.A. Lewynsky. 1985. Big Qualicum River Steelhead Fishery Investigations, 1976 to 1981. Fisheries Management Report No. 85. 28 p.

The Big Qualicum River steelhead fishery was surveyed from 1976-77 to 1980-81 to monitor angler use and success, and to assess the status of wild and hatchery steelhead stocks. Using a voluntary questionnaire with intermittent reinforcement by MOE personnel, angler effort, catch and catch rates peaked in 1977-78 but declined each year thereafter. This was partially explained by the change to catch-and-release regulations for wild steelhead, but estimated stock sizes also showed a similar trend. Redd counts peaked in 1977-78, but also declined during each of the three subsequent years. Exploitation of hatchery steelhead averaged an estimated 45%. Similar exploitation of wild steelhead dropped abruptly after the change to catch-and-release regulations.

A cursory examination of hatchery steelhead survival found no apparent relationship between smolt-to-adult survival and the mean size of released smolts. However, data were too incomplete to be conclusive.

ACKNOWLEDGEMENT

Among the many individuals who contributed to various aspects of this study, S. Hay, G. Horncastle, R. Axford and M. Lirette deserve special thanks for their energy and enthusiasm. Staff of the Department of Fisheries and Oceans at Big Qualicum Hatchery were extremely cooperative in extending the use of their equipment and facilities throughout the investigation. D. Narver, A. Tautz and P. Slaney provided many useful comments and suggestions concerning the objectives and structure of the program. R. Olmsted edited an earlier draft of this report.

This report was prepared under contract to Supply and Services Canada, DSS Contract No. 03SB.FP576-4-0258 by Western Renewable Resources, Vernon, B.C. as subcontractor to W.R. Olmsted & Associates, Inc., North Vancouver, B.C.

INTRODUCTION

Rapid declines in wild steelhead (Salmo gairdneri) abundance and angler catch in most Vancouver Island streams prompted the Ministry of Environment (MOE) to take new directions in steelhead sport fisheries management. The apparent success of hatcheries in the northwest United States in producing steelhead acceptable to anglers, encouraged MOE personnel to examine the use of hatcheries as a means of supplementing wild stocks of steelhead in British Columbia.

Since the construction of flow controls and the hatchery on the Big Qualicum River in 1963 by the Department of Fisheries and Oceans, the MOE conducted several investigations on steelhead biology and the sport fishery (i.e. Peterson and Lyons 1968; Burns 1970; Hooton and Narver 1976; Hooton 1977; Hooton and Hay 1978). In recent years emphasis has been directed towards increasing the production of wild steelhead and improving the quality and abundance of hatchery steelhead to the creel.

The objective of this report is to summarize the results of investigations conducted in 1976-77 (Hooton 1977), 1977-78 (Hooton and Hay 1978) and 1978-79 to 1980-81. Study objectives were to:

1. Determine the spatial and temporal distribution of angler effort and catch.
2. Assess the efficacy of the voluntary on-site questionnaire.
3. Examine recapture frequency of adult steelhead by anglers.
4. Estimate the relative stock size of wild and hatchery steelhead in the Big Qualicum River.
5. Estimate exploitation (and survival) of wild and hatchery steelhead stocks.
6. Examine the effect of broodstock selection on the winter sport fishery.
7. Describe wild and hatchery steelhead life history.

DESCRIPTION OF STUDY AREA

Big Qualicum River is a small, relatively short (10 km), controlled flow river located on the central east coast of Vancouver Island (Fig. 1). The river is accessed by a short road connecting the Vancouver Island Highway and the hatchery

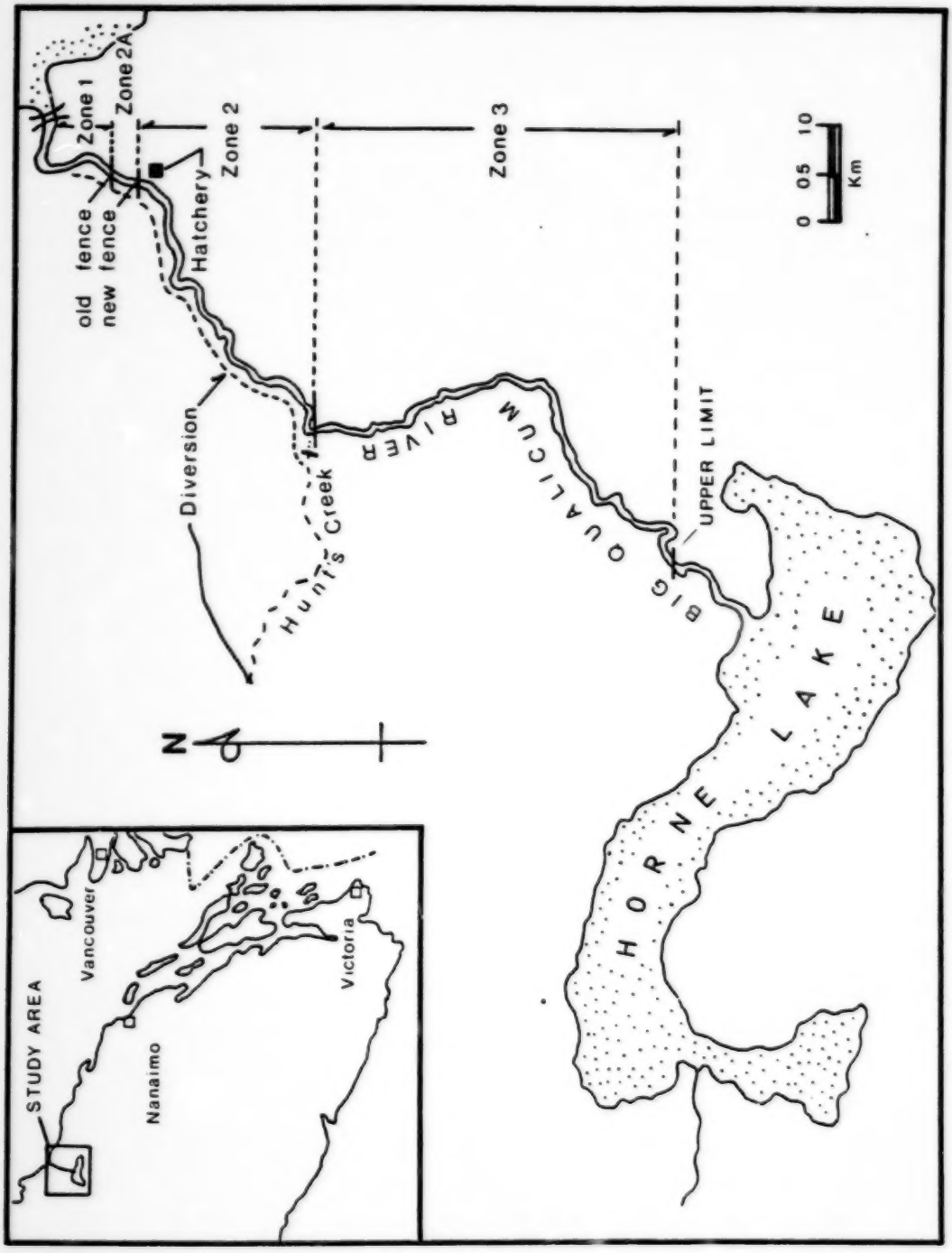


Figure 1. Big Qualicum River drainage showing designated fishing zones.

complex. Department of Fisheries and Oceans' policy restricts anglers to foot access only to areas upstream from the hatchery. An Indian Reserve on both sides of the river downstream from the hatchery is accessible to natives only. Thus, virtually all non-natives who fish the river must pass through the hatchery complex.

A noteworthy feature of the hatchery operation is the counting fence and associated traps (Fig. 1). During most creel survey periods the fence and traps were open and steelhead had free access to upstream reaches. However, the fence undoubtedly caused a majority of the fish to linger in pools immediately downstream. This behavior may have been more pronounced among hatchery fish because of their tendency to home to the site they were released as smolts (i.e. the hatchery). Together these factors served to concentrate both fish and anglers.

Winter steelhead enter Big Qualicum River in December through April. Flow control works at the Horne Lake outlet (Fig. 1) ensure that the river is always fishable during this period. The stable flow usually attracts large numbers of anglers when other streams are unfishable due to freshets. Mean flows of the Big Qualicum River between 1975-76 and 1981-82 ranged from a low of 4.8 m^3/sec in April to a high of 8.9 m^3/sec in January.

Regulations governing steelhead harvest changed several times during the study period. Prior to the 1977-78 season, catch limits were two steelhead per day and 40 per season. During the 1977-78 and 1978-79 seasons the catch limits were reduced to 20 fish per year of which not more than ten could be from a single stream. At the beginning of the 1980-81 season steelhead catch limits were further reduced to ten per year of which no more than one per day, two per month, and five per year could be wild. Additionally, wild steelhead were subject to catch-and-release-only during February and March, 1980 and from December through February in subsequent seasons.

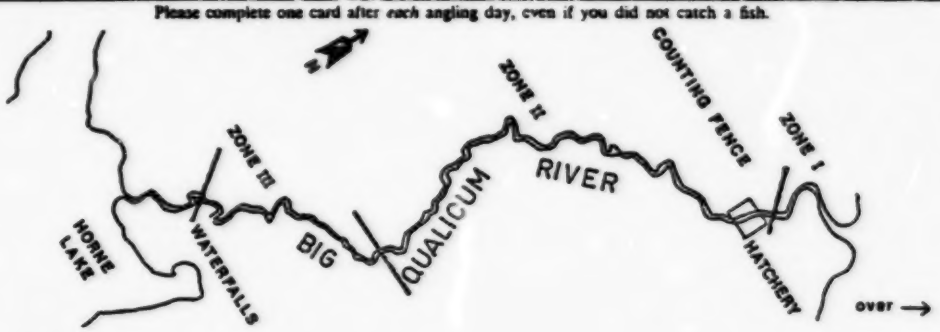
METHODS

A voluntary on-site questionnaire (Fig. 2) was used to determine angler use, average number of wild and hatchery steelhead creeled and released per hour, and total number of wild and hatchery steelhead captured (creeled and released). Census procedures have been described elsewhere (Hooton 1977; Hooton and Hay 1978). In 1977-78, 1978-79 and 1979-80 MOE personnel were on-site most days to improve angler participation with the questionnaire and to obtain more steelhead for examination. The number of steelhead creeled by native anglers on Indian Reserve reaches was estimated from comments to project staff by natives employed at the hatchery.

Date: | Name: | Phone No.: | Nº 959

Zone	Estimated Hours Fished/Zone	Fish Kept/Zone		Fish Released/Zone	
		Adipose Fin Present	Adipose Fin Missing	Adipose Fin Present	Adipose Fin Missing
I					
II					
III					

Please complete one card after *each* angling day, even if you did not catch a fish.



COMMENTS:

(front)

(back)

Please attach one of these stubs to the *head* of each marked fish killed and leave the head in the bucket provided at the hatchery; also have someone from the hatchery take a *scale sample* from the fish.

Nº 959

Name_____

Date_____

Zone_____
(in which fish was caught)

Nº 959

Name_____

Date_____

Zone_____
(in which fish was caught)

STEELHEAD CREEL SURVEY

The Fish and Wildlife Branch is attempting to determine the contribution of hatchery reared steelhead to total angler catch on the Big Qualicum River. Your help in carefully completing this card and returning the heads of all adipose clipped steelhead to the Big Qualicum Hatchery is essential to the study. A small prize is offered for interest.

Information obtained from anglers will aid in developing methods which maximize the adult return from hatchery-reared smolts.

Figure 2. Steelhead angler report cards used at Big Qualicum River, 1976–1981.

Anglers were requested to return heads of hatchery steelhead (identified by a missing adipose fin) and scale samples from all steelhead to collection depots located at access points to popular fishing areas. Signs advertising and explaining the program were posted in strategic locations. To encourage angler response, two monthly merchandise prizes ($50 value) in 1976-77 and two monthly $25 cash prizes in 1977-78 to 1980-81 were awarded by lottery among anglers returning heads and questionnaires.

The size of wild and hatchery steelhead runs in 1976-77 and 1978-79 was calculated by summation of trap counts, fence counts, angler harvest, and snorkel counts below the hatchery fence. Calculation of run sizes in subsequent years did not include fence or snorkel counts. Because the fence was left open during these later years, trapping efficiency also changed.

To obtain estimates of steelhead recapture frequency by anglers, some steelhead captured by anglers and the trap were floy-tagged, and released between January and April, 1979. An attempt was also made to examine stream-wide movement and estimate total abundance by snorkel observations of marked and unmarked steelhead.

Sex ratios of wild and hatchery steelhead in 1976-77 and 1977-78 were based on the proportions observed among trapped fish. Estimates in 1978-79 through 1980-81 were based on the proportions observed in the angler catch.

Smolt-to-adult survival rates of hatchery steelhead were estimated by expanding the number of coded wire tags from heads returned by anglers by the estimated proportion of each tag group in the population and comparing these values to initial smolt release records. Tag returns also provided validation of ages determined from scales. Scales obtained by anglers and project personnel from wild and hatchery steelhead were prepared and aged as described by Narver and Withler (1971) except that age designation was given for complete years (i.e., .1, .2, .3, etc.).

Spawning distribution of wild steelhead was assessed by counting redds within each river zone during the peak spawning period in April (Hooton 1977; Hooton and Hay 1978).

RESULTS AND DISCUSSION

ANGLER USE, CATCH RATES AND CATCH

Steelhead angler use of the Big Qualicum River varied markedly between 1976-77 and 1980-81 (Fig. 3; Table 1). Angler use was substantially lower in 1976-77 and 1980-81 than during the other three years. The high angler effort in 1977-78 and

Table 1. Effort and steelhead catch by anglers responding to the voluntary questionnaire on the Big Qualicum River, 1976-77 to 1980-81.

	Number of Anglers Observed	Number of Anglers Responding	Reported Hours Fished				Fish Reported Creeled				Fish Reported Released				Cumulative Total Catch (percent)	Total Stream Catch Per Hour
			Zone1	Zone2	Zone3	Cumulative Total (percent)	Zone1	Zone2	Zone3	Cumulative Total (percent)	Zone1	Zone2	Zone3	Cumulative Total (percent)		
1976-77																
Dec 1-15	--	13	14	34	0	48 (3)	0	0	0	0	0	0	0	0	0	--
16-31	--	33	13	71	26	158 (11)	1	4	0	5 (4)	0	1	0	1 (1)	6 (2)	.055
Jan 1-15	--	43	48	47	10	263 (18)	7	4	1	17 (12)	3	0	1	5 (4)	22 (8)	.152
16-31	--	55	47	77	44	431 (29)	12	7	3	39 (28)	0	1	0	6 (4)	45 (16)	.137
Feb 1-14	--	67	92	102	46	671 (45)	24	7	1	71 (52)	11	7	0	24 (17)	95 (35)	.208
15-28	--	79	156	110	7	944 (64)	22	4	0	97 (71)	17	5	2	48 (35)	145 (53)	.189
Mar 1-15	--	80	239	47	2	1232 (83)	27	1	0	125 (91)	38	5	1	92 (67)	217 (79)	.250
16-31	--	51	88	44	12	1376 (93)	7	2	0	134 (98)	10	12	4	118 (86)	252 (92)	.244
Apr 1-15	--	24	34	50	11	1471(100)	1	0	1	136 (99)	9	11	0	138(100)	274(100)	.233
16-30	--	2	0	6	0	1477(100)	0	1	0	137(100)	0	0	0	138(100)	275(100)	.167
		447	731	588	158		101	30	6		88	42	8			.185 [a]
1977-78																
Dec 1-15	63	22 (35)	31	43	15	89 (1)	4	0	0	4 (1)	0	0	0	0	4 (0)	.045
16-31	186	85 (46)	194	95	8	386 (6)	14	6	0	24 (3)	3	3	0	6 (1)	30 (2)	.088
Jan 1-15	246	130 (53)	328	113	16	843 (13)	44	13	0	81 (11)	25	3	1	35 (5)	116 (8)	.188
16-31	306	216 (71)	607	156	53	1659 (27)	97	11	2	191 (26)	40	1	4	80 (12)	271 (19)	.190
Feb 1-14	392	251 (64)	767	111	63	2600 (42)	121	10	3	325 (44)	51	4	5	140 (20)	465 (32)	.208
15-28	457	248 (54)	905	142	50	3697 (59)	129	12	3	469 (63)	113	9	4	266 (38)	735 (51)	.246
Mar 1-15	415	219 (53)	929	70	10	4706 (75)	120	7	0	596 (80)	181	3	0	450 (65)	1046 (73)	.310
16-31	483	255 (53)	1015	81	23	5825 (93)	109	3	1	709 (95)	188	11	1	650 (94)	1359 (94)	.280
Apr 1-15	206	95 (46)	287	24	2	6138 (98)	28	1	1	739 (99)	39	0	0	689 (99)	1428 (99)	.220
16-30	102	34 (33)	89	18	2	6247(100)	2	3	0	744(100)	4	0	0	693(100)	1437(100)	.083
	2856	1555 (54)	5152	853	242		668	66	10		644	34	15			.230 [a]

Table 1. (p. 2, cont'd)

Period	Number of Anglers Observed	Number of Anglers Responding (percent)	Reported Hours Fished				Fish Reported Creeled				Fish Reported Released				Cumulative Total Catch (percent)	Total Stream Catch Per Hour
			Zone1	Zone2	Zone3	Cumulative Total (percent)	Zone1	Zone2	Zone3	Cumulative Total (percent)	Zone1	Zone2	Zone3	Cumulative Total (percent)		
1978-79																
Dec 1-15	186	96 (52)	207	80	3	290 (4)	2	0	0	2 (1)	0	0	0	0	2 (1)	.007
16-31	348	223 (64)	504	130	14	938 (13)	7	4	0	13 (5)	2	0	0	2 (1)	15 (4)	.020
Jan 1-15	338	288 (86)	462	336	35	1771 (24)	4	6	1	24 (10)	0	6	0	8 (4)	32 (7)	.020
16-31	333	297 (89)	357	426	79	2633 (37)	7	19	2	52 (21)	5	9	0	22 (12)	74 (17)	.049
Feb 1-14	448	362 (81)	793	451	47	3924 (55)	27	17	2	98 (40)	21	12	3	58 (32)	156 (37)	.063
15-28	413	377 (91)	601	427	16	4968 (69)	23	18	0	139 (57)	12	16	1	87 (47)	226 (53)	.067
Mar 1-15	415	345 (83)	554	329	18	5869 (83)	31	11	0	181 (75)	14	7	2	110 (60)	291 (68)	.072
16-31	352	294 (84)	517	421	19	6826 (95)	28	15	0	224 (92)	18	21	2	151 (82)	375 (88)	.088
Apr 1-15	157	120 (76)	309	36	10	7181(100)	17	1	1	243(100)	28	3	2	184(100)	427(100)	.147
16-30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2990	2402 (80)	4304	2636	241		146	91	6		100	74	10			.060
1979-80																
Dec 1-15	29	24 (83)	51	8	0	59 (1)	0	0	0	0	0	0	0	0	0	0
16-31	191	102 (53)	207	57	10	333 (7)	4	0	0	4 (3)	1	0	0	1 (0)	5 (1)	.018
Jan 1-15	255	156 (61)	249	89	13	684 (16)	5	1	0	10 (7)	4	2	2	9 (3)	19 (4)	.040
16-31	215	140 (65)	248	147	16	1095 (25)	1	6	0	17 (12)	7	6	0	22 (6)	39 (8)	.049
Feb 1-14	295	253 (86)	502	316	73	1986 (45)	10	10	2	39 (28)	18	24	5	69 (20)	108 (22)	.078
15-28	256	197 (77)	353	268	93	2700 (62)	10	13	3	65 (46)	17	25	15	126 (37)	191 (40)	.116
Mar 1-15	214	164 (77)	264	222	60	3246 (74)	10	8	1	84 (60)	32	28	13	199 (58)	283 (59)	.169
16-31	184	125 (68)	273	89	9	3617 (83)	21	0	0	105 (75)	24	9	3	235 (68)	340 (70)	.154
Apr 1-15	244	162 (66)	480	82	16	4195 (96)	29	2	0	136 (97)	77	7	3	322 (94)	459 (95)	.205
16-30	91	56 (62)	174	8	1	4378(100)	4	0	0	140(100)	18	3	1	344(100)	484(100)	.142
	1974	1379 (70)	2801	1286	291		94	40	6		198	104	42			.110

Table 1. (p. 3, cont'd)

Period	Number of Anglers Observed	Number of Anglers Responding	Reported Hours Fished				Fish Reported Creeled				Fish Reported Released				Cumulative Total Catch (percent)	Total Stream Catch Per Hour
			Zone1	Zone2	Zone3	Cumulative Total (percent)	Zone1	Zone2	Zone3	Cumulative Total (percent)	Zone1	Zone2	Zone3	Cumulative Total (percent)		
1980-81																
Dec 1-15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
16-31	--	24	56	16	0	72 (9)	1	0	0	1 (2)	2	0	0	2 (2)	3 (2)	.04
Jan 1-15	--	31	92	20	11	195 (24)	5	0	0	6 (11)	7	1	2	12 (15)	18 (13)	.12
16-31	--	42	86	42	36	359 (45)	12	4	0	22 (40)	4	8	7	31 (38)	53 (39)	.21
Feb 1-14	--	44	125	48	12	544 (68)	11	3	0	36 (65)	18	2	4	55 (67)	91 (68)	.21
15-28	--	30	85	36	12	677 (84)	8	1	0	45 (82)	7	8	0	70 (85)	115 (84)	.18
Mar 1-15	--	15	54	0	0	731 (91)	4	0	0	49 (89)	5	0	0	75 (92)	124 (91)	.17
16-31	--	17	64	6	3	804(100)	6	0	0	55(100)	6	1	0	82(100)	137(100)	.18
Apr 1-15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
16-30	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total		203	562	168	74		47	8	0		49	20	13			.16 [a]

[a] mean (over all periods and zones)

1978-79 was not completely unexpected as both wild and hatchery steelhead runs were high in 1977-78 (cf., Fig. 3; Table 2). The high use in 1978-79 was likely a lagged response, resulting from the high average success in 1977-78 (Fig. 4). The drop in angler effort in 1979-80 and 1980-81 was probably a response to low steelhead abundance (Table 2), low success rates (Fig. 4), regulation changes restricting the harvest of wild steelhead or a combination thereof. Poor angler response to the voluntary reporting program in 1980-81 also influenced angler effort figures. This factor is further discussed later in this report.

Seasonal distribution of angler effort did not appear to vary significantly between years; maximum effort occurred between mid-January and the end of March in all five years (Table 1). The section of Zone 1 between the old fence and the upstream limit of the Indian Reserve (approximately 50 m) was the preferred angling area prior to the construction of the new counting fence in 1978 (Table 1). The new location caused a re-distribution of effort towards Zone 2A (Fig. 1). Zone 3, which usually contained less steelhead and required a three to eight kilometer hike, received the least use. Effort in Zone 2 above the fence(s) was intermediary during all five seasons.

Reported steelhead catch per hour (wild and hatchery combined) peaked at 0.23 fish per hour in 1977-78, declined to a low of 0.06 fish per hour in 1978-79, and then increased thereafter (Fig. 4). The changes in catch rate from 1976-77 to 1978-79 corresponded to similar changes in abundance, but the increases reported in 1979-80 and 1980-81 did not coincide as well to steelhead abundance or angler catch (cf., Table 1; Fig. 4 and 5). Higher catch rates in the latter two seasons probably reflected multiple recaptures of wild and, to a lesser extent, hatchery steelhead which would have been creeled in the absence of changing angler attitudes and newly imposed harvest restrictions. The number of steelhead caught per hour, which showed a "normal" distribution during the 1976-77 and 1977-78 seasons, was skewed to the later part of the season in 1978-79 and 1979-80 (Table 1). This was an apparent response to an unexplained delay in the return of the wild adult steelhead and selection of late returning fish as parent stock for hatchery steelhead expected to return between 1978 and 1980.

Reported numbers of steelhead creeled and released (wild and hatchery combined) also peaked in 1977-78 (Fig. 5). However, like catch rates, the relationship between catch and estimated steelhead abundance was not consistent (cf., Fig. 5, Table 1).

The observed increase in catch rates in 1979-80 and 1980-81 may have been partially due to low angler effort or the change to catch-and-release regulations for wild steelhead (i.e., repeat capture, change in angler integrity, etc.) or both. The estimated recapture rate of 25%, which was similar to estimates from the Campbell/Quinsam River (Hooton and Carswell 1981), could

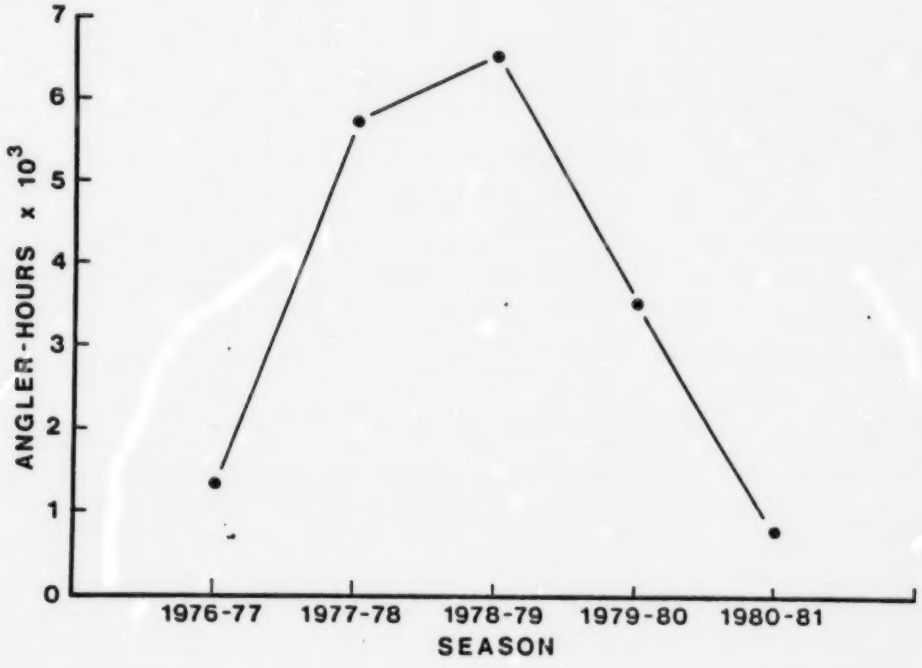


Figure 3. Total hours reported fished by participating anglers, Big Qualicum River, December 15 - March 31, 1976 to 1981.

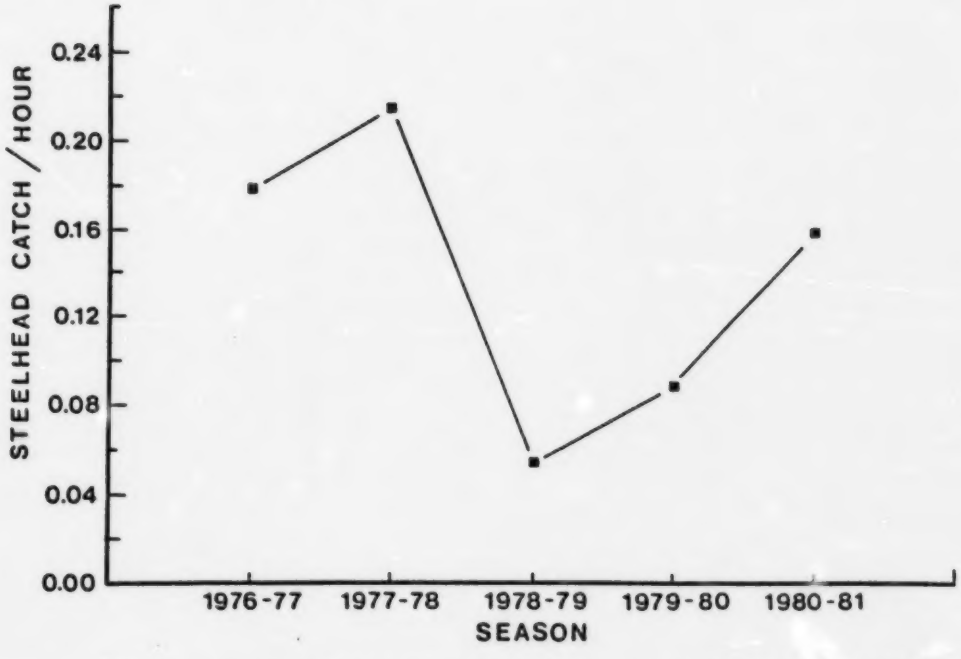


Figure 4. Steelhead catch per hour by participating anglers, Biq Qualicum River, December 15 - March 31, 1976 to 1981.

Table 2. Distribution of wild and hatchery steelhead reported captured by anglers from the three Big Qualicum River zones, 1977-78 to 1980-81.

Period	Wild Steelhead						Hatchery Steelhead						Proportion of Hatchery Steelhead in Total Catch
	Creeled			Released			Creeled			Released			
	Zone1	Zone2	Zone3	Zone1	Zone2	Zone3	Zone1	Zone2	Zone3	Zone1	Zone2	Zone3	
1977-78													
Dec 1-15	3	0	0	0	0	0	1	0	0	0	0	0	.250
16-31	7	2	0	2	3	0	7	4	0	1	0	0	.461
Jan 1-15	19	6	0	10	1	1	25	7	0	15	2	0	.570
16-31	23	1	2	20	1	2	74	10	0	20	0	2	.684
Feb 1-14	26	2	1	21	3	4	95	8	2	30	1	1	.706
15-28	33	0	0	33	5	3	96	12	3	80	4	1	.726
Mar 1-15	27	0	0	50	2	0	93	7	0	131	1	0	.746
16-31	14	0	0	55	6	1	95	3	1	133	5	0	.757
Apr 1-15	5	0	0	15	0	0	23	1	1	24	0	0	.710
16-30	2	1	0	3	0	0	0	2	0	1	0	0	.333
	159	12	3	209	21	11	509	54	7	435	13	4	.711[a]
	174			241			570			452			
1978-79													
Dec 1-15	2	0	0	0	0	0	0	0	0	0	0	0	0
16-31	4	2	0	2	0	0	3	2	0	0	0	0	.384
Jan 1-15	3	3	0	0	4	0	1	3	1	0	2	0	.412
16-31	6	12	2	4	8	0	1	7	0	1	1	0	.238
Feb 1-14	11	5	1	1	14	7	2	12	1	7	5	1	.418
15-28	9	6	0	9	9	1	14	12	0	3	7	0	.514
Mar 1-15	13	4	0	6	3	2	16	7	0	8	4	0	.569
16-31	5	4	0	11	6	0	23	11	0	7	15	2	.690
Apr 1-15	5	1	1	11	1	1	12	0	0	17	2	1	.615
16-30	--	--	--	--	--	--	--	--	--	--	--	--	--
	58	37	4	44	45	11	74	54	2	43	36	4	
	99			100			130			83			.517[a]

Table 2. (p. 2, cont'd)

Period	Wild Steelhead						Hatchery Steelhead						Proportion of Hatchery Steelhead in Total Catch
	Creeled			Released			Creeled			Released			
	Zone1	Zone2	Zone3	Zone1	Zone2	Zone3	Zone1	Zone2	Zone3	Zone1	Zone2	Zone3	
1979-80													
Dec13-15	0	0	0	0	0	0	0	0	0	0	0	0	0
16-31	4	0	0	1	0	0	0	0	0	0	0	0	0
Jan 1-15	2	0	0	4	1	2	3	1	0	0	1	0	.357
16-31b	0	0	0	6	4	0	1	6	0	1	2	0	.500
Feb 1-14	0	0	0	18	19	4	10	10	2	0	5	0	.397
15-28	0	0	0	12	19	11	10	13	3	5	6	4	.494
Mar 1-15	0	0	0	20	21	7	10	8	1	12	7	6	.478
16-31	0	0	0	12	6	2	21	0	0	12	3	1	.649
Apr 1-15	0	0	0	53	5	3	29	2	0	24	2	0	.483
16-30	0	0	0	12	1	0	4	0	0	6	2	1	.500
	6	0	0	138	76	29	88	40	6	60	28	12	
	6			243			134			100			.484[a]
1980-81													
Dec 1-15	--	--	--	--	--	--	--	--	--	--	--	--	--
16-31	0	0	0	1	0	0	1	0	0	1	0	0	.667
Jan 1-15	0	0	0	4	1	2	5	0	0	3	0	0	.533
16-31	0	0	0	1	4	4	12	4	0	3	4	3	.743
Feb 1-14	0	0	0	12	2	3	11	3	0	6	0	1	.588
15-28	0	0	0	4	4	0	8	1	0	3	4	0	.667
Mar 1-15	1	0	0	3	0	0	3	0	0	2	0	0	.556
16-31	0	0	0	3	1	0	6	0	0	3	0	0	.692
Apr 1-15	--	--	--	--	--	--	--	--	--	--	--	--	--
16-30	--	--	--	--	--	--	--	--	--	--	--	--	--
	1	0	0	28	12	9	46	8	0	21	8	4	
	1			49			54			33			.635[a]

[a] mean (over all periods and zones)
[b] wild steelhead release imposed on January 16, 1980

account for some of the observed increase. The unexpected high estimated rate of hatchery steelhead release may have resulted from angler caution (fear of mis-identification), the contemporary trend among anglers to release most steelhead, and/or from exaggeration of the number of fish caught and released.

Zone 1 yielded the largest catch and was the most favoured among anglers in all five years surveyed (Table 1 and 2). Zones 2 and 3, however, began to attract more anglers after 1978, and as a result, the proportion of fish caught in these two zones was substantially larger during the later years. Relocation of the counting fence further upstream was partially responsible for the shift in distribution.

In 1978-79, prior to the mandatory release of wild steelhead, 50% (99) of the wild steelhead and 37% (83) of the hatchery steelhead were reported released (Table 2). During this latter period of mandatory wild steelhead release, anglers continued to release 43% (1979-80) and 38% (1980-81) of the hatchery steelhead captured.

ACCURACY OF CREEL DATA

The accuracy of angler use and steelhead catch estimates for the five years surveyed was uncertain. Low estimates in 1976-77, 1979-80 and 1980-81 resulted from low angler participation with the voluntary questionnaire (Table 1). In 1977-78, Hooton and Hay (1978) determined that contact by MOE staff increased cooperation. Vigilance and frequent verbal reminders to anglers in 1978-79 and 1979-80 substantially increased the number of anglers participating relative to the numbers observed fishing (Table 1). The absence of staff on-site during the 1980-81 season again resulted in poor angler participation. Because of the variability in reporting the days fished and steelhead caught, creel survey estimates must be treated with caution.

Comparison of estimates derived from the on-site survey and the post-season mail questionnaire (random sample of all licensees) revealed large differences, particularly between estimates of the number of steelhead released (Table 3). Similar discrepancies have been reported elsewhere (Steelhead Harvest Analysis 1978-79). It was noteworthy that differences were substantially smaller during 1978-79 and 1979-80 when project personnel constantly reminded anglers to complete and return the on-site survey cards. Differences can be partially explained by the level of on-site angler participation, but mailed questionnaires have been found to overestimate population parameters (Ford 1982; Burns and Brown 1975; Hicks 1964).

Table 3. Comparisons of estimates of days fished, steelhead creeled and steelhead released by on-site and mail questionnaires for five consecutive fishing on the Big Qualicum River.

	Days Fished			Steelhead Creeled			Steelhead Released		
Season	Mail	On-site	O/M*100	Mail	On-site	O/M*100	Mail	On-site	O/M*100
1976-77	1656	447	27	253	137	54	520	138	27
1977-78	4085	1555	38	786	744	95	1814	693	38
1978-79	3599	2402	67	384	243	63	513	184	36
1979-80	2005	1379	69	206	158	77	866	344	40
1980-81	3082	203	7	327	55	17	2246	82	4

ABUNDANCE AND EXPLOITATION OF WILD AND HATCHERY STEELHEAD

The largest return of wild and hatchery steelhead to the Big Qualicum River occurred in 1977-78 but abundance declined consistently thereafter (Table 4). The proportion of hatchery steelhead in the total steelhead catch did not change substantially between 1977-78 and 1979-80 (Fig. 6; Table 2). The relative abundance of hatchery steelhead increased by 64% in 1980-81, but the low reported total capture of 131 adults (attributed to poor angler participation with the questionnaire) was skewed to Zone 1 and 2A where hatchery steelhead and anglers concentrate.

Between 1978 and 1981 anglers returned 18 heads containing coded wire tags from steelhead captured in the nearby Little Qualicum and Englishman Rivers. All 18 steelhead originated from Big Qualicum River Hatchery releases between 1975 and 1978. Ten steelhead originally released in the Little Qualicum River (1978 brood), three in the Millstone River (1977 brood), one in the Chase River (1977 brood), and one in Rosewell Creek (1978 brood) were recovered in the Big Qualicum River by anglers. All transplants to the above streams were Big Qualicum River stock. The full extent of straying could not be estimated. Run size, exploitation, and survival estimates did not include strays.

Exploitation of hatchery steelhead averaged 45%. Estimates varied somewhat among the years examined, but no consistent pattern emerged (Table 4). Estimates of exploitation were similar for wild steelhead in 1977-78 and 1978-79 but declined abruptly to about 7% in 1980 with the change to mandatory release; subsequent exploitation was due primarily to harvest by native Indians in Zone 1 (Table 4). Estimates included wild and hatchery steelhead captured for broodstock at the hatchery fence and elsewhere.

The catch-and-release restriction applied to wild steelhead virtually eliminated their exploitation, but their absolute abundance, and abundance relative to hatchery steelhead, continued to decline. This was not necessarily unexpected as the effect of a decrease in fishing mortality requires at least 4-5 years (i.e., one generation) to produce a detectable change.

Of 12 steelhead captured by angling, tagged, and released during 1978-79, three (25%) were recaptured by anglers. Five of 19 steelhead (26%) trapped, tagged, and released were recaptured by anglers. These sample sizes were considered to be too small to yield precise estimates of multiple recapture frequency or to estimate exploitation.

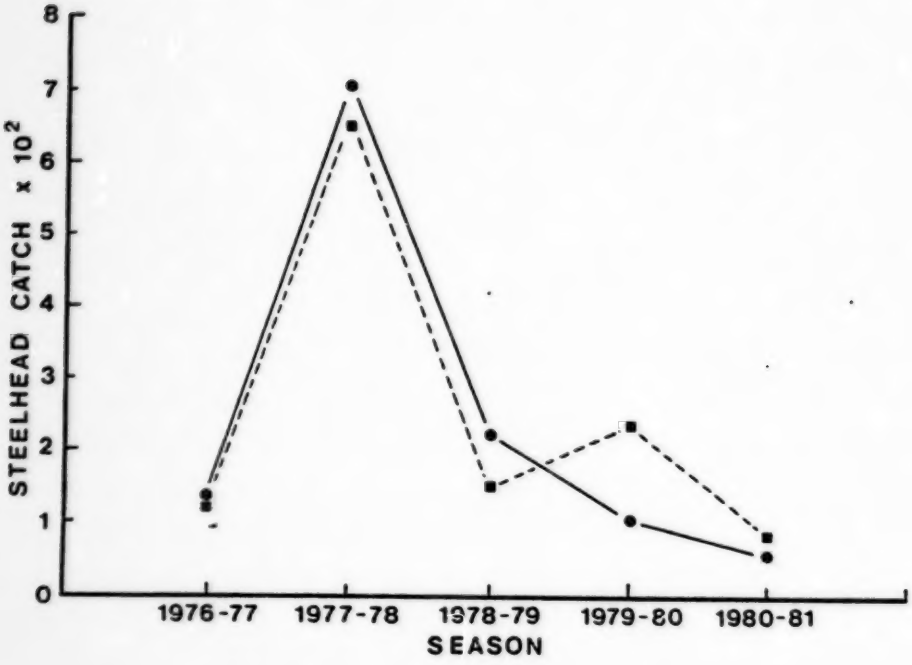


Figure 5. Total numbers of steelhead reported creeled (———) and released (-----) by participating anglers, Big Qualicum River, December 15 - March 31, 1976 to 1981.

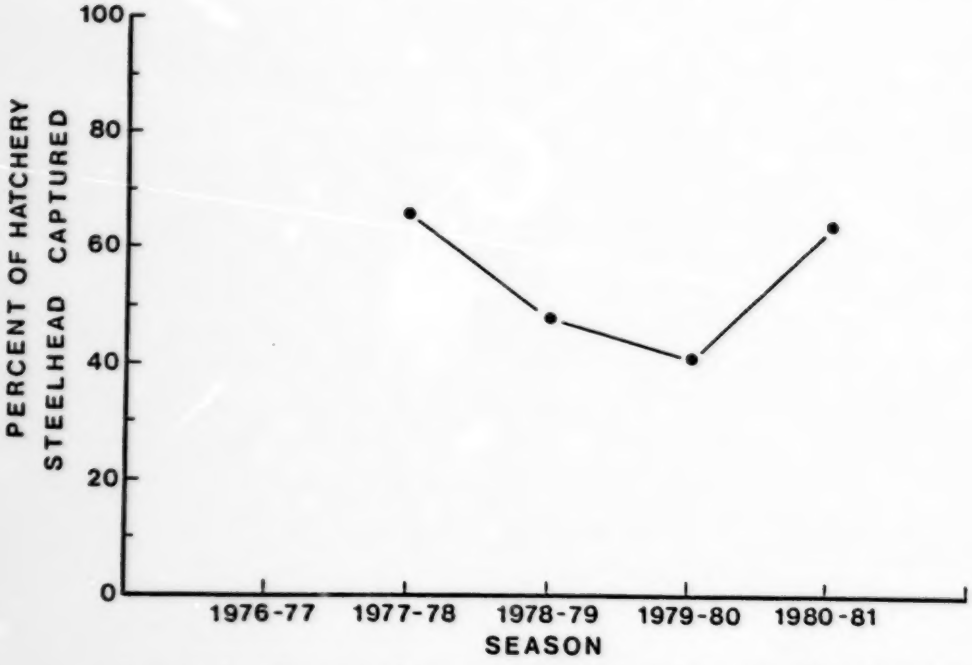


Figure 6. Estimated proportion of hatchery steelhead captured (creeled and released), Big Qualicum River, 1977 to 1981.

Table 4. Estimated run size and exploitation of adult wild and hatchery steelhead returning to the Big Qualicum River in 1977-78 to 1980-81.

	Zone 1 & 2A					
	Angler Harvest					
Year	Non-Native	Native	Escapement	Fence Count [a]	Total Run	Exploitation (%)
			WILD			
1976-77	43	n/a[b]	42	256	n/a	--
1977-78	159	42	41	247	489	46.4
1978-79	58	17	22	230	327	35.5
1979-80 [c]	6	13	34	n/a	300	6.3
1980-81	1	13	29	n/a	166	8.4
			HATCHERY			
1976-77	58	n/a	58	345	n/a	--
1977-78	509	108	107	609	1333	50.9
1978-79	88	18	24	258	388	41.8
1979-80	88	17	46	n/a	346	43.6
1980-81 [d]	46	22	51	n/a	288	n/a

[a] includes trap count
[b] n/a - not available
[c] wild steelhead release was imposed on February 6, 1980
[d] values do not include data from early December or the entire month of April

HATCHERY STEELHEAD SURVIVAL

Estimated smolt-to-adult survival rates ranged from 0.4% to 4.2%. For the years which could be compared, survival was lower than predicted (Table 5). There was no obvious relationship between survival rate and the mean size of the smolts released. Variations in smolt quality (i.e. health) between years may have obscured a relationship. The inability to detect a relationship may also have been a function of analysis; a simple mean weight was used, as opposed to a weighted mean (weighted by size). Regardless, it is noteworthy that there was an observed seven-fold difference in the estimated survival of "small" and "large" 1974 brood smolts.

TEMPORAL DISTRIBUTION OF RETURNING HATCHERY STEELHEAD

The effects of selecting late returning steelhead as brood stock was evident in 1976-77 through 1979-80. During these four seasons approximately 70% of the hatchery stock were estimated to have returned after February 15; 82% of the hatchery stock returned after February 15 in 1979-80 (Table 2 and 4). Attempts to distribute the time of return of hatchery steelhead more uniformly throughout the season by selection of earlier run fish began with the 1978 brood and results were clearly evident by 1980-81 when only 35% of the hatchery steelhead entered the river after February 15. Redistribution of the hatchery stock run timing toward the early season when fish quality and angler use was highest was well received by anglers.

LIFE HISTORY

Of 1,194 wild and hatchery steelhead sampled betwen 1976 and 1981, most had legible ocean growth zones (Table 6). Identification of freshwater annuli, however, was more difficult particularly among wild steelhead.

The majority of wild and hatchery steelhead examined spent two years in the ocean before returning to the Big Qualicum River (Table 7 and 8). A moderate number spent three years. The oldest maiden hatchery and wild steelhead were total age 4 and 6, respectively. Most wild steelhead had spent two years in the Big Qualicum River before emigrating. No obvious shift in age distribution was evident during the five years sampled.

Spawning checks were identified on approximately 8% of all steelhead examined. Repeat spawning was consistently higher among females than males (regardless of origin) sampled in 1977-78 to 1979-80 (Table 9). No consistent pattern emerged between wild and hatchery steelhead among the three years that could be compared. More females than males were sampled with scales showing more than one spawning check (Table 8). The majority of steelhead classified as repeat spawners, spawned at the end of their second ocean year and were returning to spawn a second time the next year.

Table 5. Smolts released, estimated run size and estimated survival of Big Qualicum River hatchery steelhead.

Smolts Released								
Brood Year	Number	CWT Code	Average Weight (g)	Angling Season	Number of Tags Recovered (proportion of total examined)	Estimated Run Size	Predicted Run Size[a]	Estimated Smolt-to-adult Survival[b] (%)
1974	23085	W/B/R/G	57	1977-78	108 (.19)	252[c]	--	2.9
	9761	W/B/G/B	21	1977-78	7 (.01)	16	--	0.4
1975	29149	1/2/6	42	1977-78	458 (.80)	1065	--	
				1978-79	55 (.43)	162	685	4.2
1976	23000	1/12/10	68	1978-79	72 (.56)	211	--	
				1979-80	43 (.37)	128	1088	1.5
1977	18446	16/12/34	50	1978-79	1 (.01)	4	--	
				1979-80	64 (.55)	190	--	
				1980-81	45 (.58)	212	597	2.2
1978[d]	20227	17/12/28	51	1979-80	1 (.01)	4	--	
				1980-81	30 (.38)	139	376	0.7

[a] using the method of Royal (1972)
[b] does not include repeat spawners
[c] includes adults which returned during 1976-77 fishery
[d] results incomplete as full return not expected until 1981-82

Table 6. Number of scale sampled Big Qualicum River steelhead with legible freshwater and ocean zones[a].

Year	Origin	Source		Number of Scales With Legible Ocean Zone (%)	Number of Scales With Legible Freshwater Zone (%)
		Angler	Trap		
1976-77	hatchery	73	9	82 (100)	73 (89)
	wild	38	33	70 (99)	43 (61)
		111	42	152	116
1977-78	hatchery	226	147	348 (84)	349 (85)
	wild	50	24	74 (100)	57 (77)
		276	171	422	406
1978-79	hatchery	139	43	180 (99)	180 (99)
	wild	85	26	111 (100)	85 (77)
		224	69	291	265
1979-80	hatchery	139	28	161 (96)	154 (94)
	wild	20	5	25 (100)	14 (56)
		159	33	186	168
1980-81	hatchery	67	—	67 (100)	63 (94)
	wild	2	—	2 (100)	2 (100)
		69		69	65

[a]repeat spawners were not included in 1976-77 only

Table 7. Number (percent) of maiden hatchery and wild steelhead by age group sampled from angler catch and the Big Qualicum fence, 1976-77 to 1980-81.

		Age Group									
Year	Origin	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.2
1976-77	hatchery	3 (4)	64 (90)	4 (6)	--	--	--	--	--	--	--
	wild	--	4 (10)	--	--	22 (55)	3 (7)	--	9 (22)	1 (3)	1 (3)
1977-78	hatchery	1 (0)	234 (80)	49 (17)	--	10 (3)	--	--	--	--	--
	wild	--	3 (6)	--	--	37 (70)	11 (21)	--	2 (3)	--	--
1978-79	hatchery	2 (1)	108 (69)	47 (30)	--	--	--	--	--	--	--
	wild	1 (1)	--	--	--	58 (68)	10 (12)	2 (2)	13 (15)	1 (1)	--
1979-80	hatchery	1 (1)	88 (66)	43 (32)	--	2 (1)	--	--	--	--	--
	wild	--	--	--	--	7 (64)	4 (36)	--	--	--	--
1980-81[a]	hatchery	--	29 (47)	32 (51)	--	1 (2)	--	--	--	--	--
	wild	--	1 (50)	--	--	--	1 (50)	--	--	--	--

[a]trap not in operation

Table 8. Number and spawning pattern of repeat wild and hatchery steelhead spawners sampled from angler catch and the Big Qualicum fence, 1976-77 to 1980-81.

Year	Origin	Post Smolt Age/Spawning Designation						
		.S1	.SS1	.1S1	.1SS1	.1SSS1	.2S1	.2SS1
				MALE				
1976-77	hatchery	1	-	-	-	-	-	-
	wild	1	-	-	3	-	-	-
1977-78	hatchery	1	1	3	-	-	-	-
	wild	-	-	1	-	-	-	-
1978-79	hatchery	-	-	1	-	-	-	-
	wild	-	-	1	-	-	1	-
1979-80	hatchery	-	-	2	-	-	-	-
	wild	-	-	1	-	-	-	-
1980-81	hatchery	-	-	-	-	-	-	-
	wild	-	-	-	-	-	-	-
All years	hatchery	2	1	6	-	-	-	-
	wild	1	-	3	3	-	1	-
				FEMALE				
1976-77	hatchery	-	-	-	-	-	1	-
	wild	-	-	-	3	-	1	1
1977-78	hatchery	6	1	12	-	-	-	-
	wild	-	-	9	2	-	-	-
1978-79	hatchery	-	-	15	3	-	-	-
	wild	-	-	7	-	-	-	-
1979-80	hatchery	-	-	14	4	1	-	-
	wild	-	-	1	-	-	1	-
1980-81	hatchery	-	-	1	-	-	-	-
	wild	-	-	-	-	-	-	-
All years	hatchery	6	1	42	7	1	-	-
	wild	-	-	17	5	-	1	-

Table 9. Repeat spawning frequencies of wild and hatchery steelhead (by sex) captured in the Big Qualicum River, 1977-78 to 1979-80.

Year	Origin	Number (%) Repeat Spawners	
		Male	Female
1977-78	hatchery	5 (3.5)	12 (5.9)
	wild	1 (2.9)	11 (27.5)
1978-79	hatchery	1 (1.9)	18 (14.3)
	wild	2 (4.4)	7 (10.8)
1979-80	hatchery	2 (2.7)	19 (22.1)
	wild	1 (9.1)	2 (14.3)
All years	hatchery	8 (2.9)	49 (11.8)
	wild	4 (4.4)	20 (16.8)

Steelhead returning after one ocean year averaged 43 cm in length (Table 10 and 11). Two- and three-ocean fish averaged 67 cm and 79 cm, respectively. No meaningful differences were observed between male and female or between wild and hatchery length-at-age. No consistent difference in mean length-at-age was evident among the five years despite the large differences in apparent cohort strength (cf., Table 4, 5, 10 and 11).

Males were consistently less abundant than females regardless of origin or sampling method (Table 12). However, females occurred more frequently in the angler catch than in the trap. No significant change in the sex ratios of wild or hatchery steelhead was evident during the five years surveyed.

REDD COUNTS

Zone 2 contained the most redds during four of the five years surveyed (Table 13). Counts in Zone 1 and 3 were similar and generally lower. The relationship between redd counts and escapement could not be examined because redd life, redd size, number of redds per female, and/or the incidence of test digging could not be determined. However, redds were enumerated in a similar manner each year; their abundance was closely associated ($r = .99$) with estimated run size.

MANAGEMENT RECOMMENDATIONS

1. The use of a voluntary report system to estimate angling effort and steelhead catches produced reliable results only when project staff persistently requested anglers to complete report cards. While this practice of reinforcement did appear to produce more detailed and probably more accurate days fished and fish released data than those available from the Steelhead Harvest Analyses, the latter data source is strongly preferred from a cost perspective.

2. Existing data indicate that manipulation of the timing of the hatchery steelhead run by selecting wild parents returning in December through February, has produced the desired result. This practice should continue.

3. The concentration of steelhead and anglers immediately downstream from the hatchery fence is a function of: (a) the fence serving as a partial migration barrier; (b) smolts being released at this site; and (c) the no-access policy of the Qualicum Indian Band. Of these three identified causes, change in access policy holds the most promise for improving the quality of the fishery. Unrestricted angler access between tidal water and the hatchery would alleviate crowding and re-distribute catch. In this context senior MOE staff, and perhaps sport fishing representatives, should make an attempt to negotiate access by non-native anglers to reserve lands.

Table 10. Mean fork length and size range (cm) of Big Qualicum River maiden hatchery steelhead of known post-smolt life history, 1976-77 to 1980-81.

Year	Fork Length Statistic	Ocean Age .1 Male	Ocean Age .1 Female	Ocean Age .2 Male	Ocean Age .2 Female	Ocean Age .3 Male	Ocean Age .3 Female
1976-77	mean	43.8	47.0	65.1	65.9	76	77
	N	2	1	28	33	1	2
	range	42.0-45.5	-	53.0-72.0	51.0-75.0	-	76.0-78.0
1977-78	mean	-	50.0	69.6	67.6	80.6	79.4
	N	-	1	110	182	18	57
	range	-	-	62.0-82.5	60.0-85.0	71.0-90.0	65.0-87.0
1978-79	mean	43.0	-	67.9	68.9	84.3	83.0
	N	2	-	54	51	8	41
	range	42.0-44.0	-	58.0-80.0	63.0-76.5	67.0-94.0	68.0-88.5
1979-80	mean	46.0	-	67.0	65.0	84.9	78.9
	N	1	-	49	18	4	25
	range	-	-	59.5-75.0	56.5-72.5	81.0-89.5	70.0-87.0
1980-81	mean	-	-	65.4	65.3	83.8	76.5
	N	-	-	19	11	13	19
	range	-	-	50.6-71.2	58.2-72.0	75.2-94.0	66.5-82.2
All years	mean	43.9	48.5	68.0	67.4	82.5	79.9
	N	5	2	260	295	44	114
	range	42.0-45.5	47.0-50.0	50.6-82.5	51.0-85.0	67.0-94.0	65.0-88.5

Table 11. Mean fork length and size range (cm) of Big Qualicum River maiden wild steelhead of known post-smolt life history, 1976-77 to 1980-81.

Year	Fork Length Statistic	Ocean Age .1 Male	.1 Female	.2 Male	.2 Female	.3 Male	.3 Female
1976-77	mean	45.0	-	61.7	64.1	86	75.6
	N	1	-	18	10	1	4
	range	-	-	51.7-74.0	53.5-71.0	-	66.5-86.0
1977-78	mean	-	-	70.8	68.3	79.1	78.1
	N	-	-	18	32	5	7
	range	-	-	63.0-77.5	62.5-80.0	75.0-90.0	75.0-81.0
1978-79	mean	43.1	-	69.9	68.0	79.3	79.5
	N	3	-	24	58	2	12
	range	38.5-42.5	-	59.0-78.0	60.0-77.5	73.5-85.0	73.0-83.0
1979-80	mean	-	-	66.5	64.4	-	79.3
	N	-	-	1	7	-	4
	range	-	-	-	60.0-68.5	-	75.0-86.0
1980-81[a]	mean	-	-	-	-	78.3	-
	N	-	-	-	-	2	-
	range	-	-	-	-	78.0-78.5	-
All years	mean	43.6		67.7	67.5	79.7	78.5
	N	4		61	107	10	27
	range	38.5-45.0	-	51.7-78.0	53.5-80.0	73.5-90.0	66.5-86.0

[a]trap not in operation

Table 12. Numbers and sex ratios of wild and hatchery steelhead sampled from angler catch and the Big Qualicum fence, 1977-78 to 1979-80.

		Angler			Trap			Total		
Year	Origin	M	F	F:M	M	F	F:M	M	F	F:M
1977-78	hatchery	164	239	1.46:1	171	231	1.35:1	335	470	1.41:1
	wild	24	26	1.09:1	52	62	1.19:1	76	88	1.16:1
1978-79	hatchery	44	104	2.38:1	22	47	2.13:1	66	151	2.33:1
	wild	32	53	1.67:1	30	36	1.20:1	62	89	1.43:1
1979-80	hatchery	59	64	1.09:1	14	20	1.43:1	73	84	1.15:1
	wild	--	--	--	8	10	1.25:1	8	10	1.25:1
All years	hatchery	267	407	1.52:1	207	298	1.44:1	474	705	1.49:1
	wild	56	79	1.41:1	90	108	1.20:1	146	187	1.28:1

Table 13. Steelhead redd counts (percent) in the Big Qualicum River, 1976-77 to 1980-81.

Year	Zone 1	Zone 2	Zone 3	Total
1976-77	24 (14)	100 (56)	54 (30)	178
1977-78	51 (22)	147 (63)	36 (15)	234
1978-79	18 (15)	68 (58)	32 (27)	118
1979-80	47 (50)	26 (28)	21 (22)	94
1980-81	25 (28)	35 (39)	29 (33)	89

LITERATURE CITED

Burns, J.E. 1970. First interim report on steelhead of the Big Qualicum River. B.C. Fish and Wildlife Branch, unpublished report, Nanaimo, B.C.

Burns, D. and L. Brown. 1975. The development of in-season sport catch estimates for the Green River steelhead fishery. Washington State Game Department, unpublished progress report.

Ford, B.S. 1982. Steelhead harvest analysis 1980-81. B.C. Ministry of Environment, Fish. Tech. Circ. No. 52, Victoria, B.C.

Hicks, R.H. 1964. An evaluation of the punch card method of estimating salmon and steelhead sport catch. Agricultural Experimental Station Technical Bulletin 81, Oregon State University. Oregon State University, Oregon, U.S.A.

Hooton, R.S. 1977. Big Qualicum River steelhead investigations, progress during 1977-78. B.C. Fish and Wildlife Branch, Fish. Tech. Circ. No. 36, Victoria, B.C.

Hooton, R.S. and D.W. Narver. 1976. The Big Qualicum River steelhead program, review and recommendations. B.C. Fish and Wildlife Branch, unpublished report, Nanaimo, B.C.

Hooton, R.S. and S.E. Hay. 1978. Big Qualicum River Steelhead Investigations Progress during 1977-78. B.C. Fish and Wildlife Branch, Fish. Tech. Circ. No. 37, Victoria, B.C.

Hooton, R.S. and L.B. Carswell. 1981. Steelhead tagging studies on the Campbell and Quinsam Rivers during the 1978-79, 1979-80 and 1980-81 fishing seasons. B.C. Ministry of Environment, unpublished report, Nanaimo, B.C.

Narver, D.W. and F.C. Withler. 1971. Age and size of steelhead trout (Salmo gairdneri) in angler's catches from Vancouver Island, B.C. streams. Fisheries Research Board of Canada. Nanaimo Biological Research Station, Circular 91, Nanaimo, B.C.

Petersen, G.R. and J.C. Lyons. 1968. A preliminary study of steelhead in the Big Qualicum River. B.C. Fish and Wildlife Branch, Fisheries Management Report No. 56, Victoria, B.C.

Royal, L.A. 1972. An examination of the anadromous trout program of the Washington State Game Department. Washington State Department of Game, Olympia, U.S.A.

Steelhead Harvest Analysis. 1978-79. B.C. Ministry of Environment, Victoria, B.C.

List of previous Fisheries Technical Circulars

1984 63 Slaney, P.A., M.L. Rosenau, D.H.G. Ableson and R.L. Morley. Habitat Capability Analysis of the Nechako River for Rainbow Trout and Char and the Effects of Various Flow Regimes.

1984 64 Billings, S. Steelhead Harvest Analysis, 1983-84.

1984 65 Slaney, P.A., M.L. Rosenau, A.D. Martin, G.D. Taylor, G.E. Reid and D.H.G. Ableson. Yield, Effort, and Catch Capabilities of Resident Trout and Char Fisheries on Streams.

1984 66 Slaney, P.A., A.D. Martin, G.D. Taylor, M.L. Rosenau, G.E. Reid and D.H.G. Ableson. Towards an effective management strategy for resident salmonid stream fisheries in B.C.

1985 67 Lirette, M.G., Hooton, R.S. and W.R. Olmsted. A Summary of Wild Steelhead Smolt Enumeration and Habitat Productivity Studies at Quinsam River, 1976-1984.

1985 68 Barrett, D.T. and G.T. Halsey. Vol. 1. Fisheries Resources and Fisheries Potential of Williston and its Tributary Streams.

List of previous Management Reports

1984 79 Martin, A.D. and E.A. Parkinson. Comparison of Trophy and Traditional Rainbow Trout Fisheries on Whitetail and Whiteswan Lakes in Southeastern British Columbia, 1984.

1984 80 Parkinson, E.A. An Evaluation of the Catchable Trout Program in Lakes near Vancouver, British Columbia.

1984 81 Parkinson, E. Identification of Steelhead Stocks in the Commercial Net Fishery of the Southern British Columbia Coast.

1984 82 Martin, A.D. and J.M. Bell. Effects of a 2.5 Year Closure of the Cutthroat Fishery on the Upper St. Mary River: Management Implications of Implementing an Alternate Year Closure on East Kootenay Trout Streams.

1984 83 Parkinson, E. and R.J. Behnke. A Morphological and Electrophoretic Comparison of Rainbow Trout (Salmo gairdneri) Above and Below Barriers on Five Streams on Vancouver Island, B.C.